

EXHIBIT D

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March 14, 2024

BY EMAIL

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Alexandra Rothman
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Andrew Thomas
Assistant United States Attorneys
United States Attorney's Office
Southern District of New York
One Saint Andrews Plaza
New York, New York 10007

Re: United States v. Sung Kook (Bill) Hwang, et al., No. 22 Cr. 240 (AKH)

Dear Counsel:

Pursuant to Federal Rule of Criminal Procedure 16(b)(1)(C), we provide notice that the defense anticipates calling Sunil Wahal as an expert witness.

Set forth below are Mr. Wahal's qualifications and a summary of his anticipated testimony. We reserve the right to update, amend, and/or supplement the below summary of testimony based on further developments. Mr. Wahal's curriculum vitae is attached hereto as Exhibit A. Mr. Wahal has not testified in the last four years as an expert at trial or in a deposition.

I. QUALIFICATIONS

Professor Wahal is the Jack D. Furst Professor of Finance and Director of the Center for Responsible Investing at the W.P. Carey School of Business, Arizona State University. His research focuses on trading issues, including but not limited to trading algorithm design, the measurement of trading costs, and high frequency trading, as well as short-run and long-run investment strategies, delegated portfolio management and asset allocation for large institutional investors. His work covers both public equities and private markets.

Professor Wahal has published extensively in the Journal of Finance, the Journal of Financial Economics, the Review of Financial Studies, and numerous other journals. He is currently a consultant to Avantis Investors. He was a consultant to Dimensional Fund Advisors,

an asset management firm with over \$650 billion under management, between 2005-2008, and between 2010 and 2019. He was an executive at Dimensional Fund Advisors between 2008 and 2010, while on leave from Arizona State University. His engagement at Dimensional Fund Advisors included advising on trading issues, including algorithm design and trade cost measurement.

He is a regular speaker at academic and practitioner conferences and has given numerous presentations to sovereign wealth funds, endowments, foundations, family offices, pension systems, and registered investment advisors. He also served as an expert witness for the SEC in Case No. 2:20-cv-01402-SPG-JEM in the Central District of California.

Professor Wahal's observations and opinions are based on the materials identified in Appendix A, analyses of public data and documents produced in this litigation, his academic research, and his professional experience.

II. SUMMARY OF ANTICIPATED TESTIMONY

1. Professor Wahal is prepared to testify that while the basic economic tradeoffs associated with trading remain largely similar over the last five decades and perhaps much longer, the structure of US equity markets changed dramatically over the last two decades. The time scales for order entry, routing, modification, and cancellation, as well as the reporting of resulting trades have changed from minutes to fractions of a second over this period. During this period, trade execution became largely automated in which many market participants interact with the markets and each other using trading algorithms.

2. Archegos gained exposure to the at-issue securities by purchasing stocks directly on its own account, and by entering into total return swaps (TRS) with counterparties. The beneficial owners of the shares purchased, and the sellers of shares sold, to hedge the swap transactions were the swap counterparties. To simplify exposition, Professor Wahal refers to trades done by counterparties to hedge the swaps, as well as the trades directly done by Archegos, as "Archegos-Related Trades."

3. Professor Wahal is prepared to testify that in well-functioning equity markets there are two types of costs associated with completed trading: (a) explicit costs, including but not limited to, commissions, fees, and other fixed costs, and (b) implicit costs which include the bid-ask spread and the subsequent movement of prices.¹ Implicit costs are due to the forces of supply and demand. It has been long known that a trader who wants to trade immediately ("demands immediacy") needs someone to take the other side of the trade ("provide immediacy"). To do so, the provider of immediacy requires compensation in the form of a bid-ask spread and/or subsequent price movements. Professor Wahal will also explain that orders and trading can affect prices by conveying value-relevant information and that an investor may have to pay a premium or accept a discount to induce another party to take the other side of a trade. This will be based on Professor Wahal's research and the academic literature.

¹ A third type of cost, "opportunity cost" is discussed later.

4. Professor Wahal is prepared to testify that it is perfectly normal and expected for trading to affect prices, even when a trader undertakes maximal effort not to do so; there is nothing unusual about Archegos's trades moving prices. Professor Wahal is prepared to further testify that many of the results presented in the government's disclosures, even if correct, amount to suggesting that trading affects prices.

5. Professor Wahal's testimony will include a description of tradeoffs that large traders consider as they create and attempt to implement their trading programs. He will describe that in actualizing these trading programs, large traders create one or more "parent orders" within or across days, which embody inherent tradeoffs.

6. A large trader, such as Archegos, makes a series of dynamic and interrelated decisions that reflect tradeoffs among at least three considerations:

- a) how much they want to trade ("Quantity");
- b) the extent to which they want to reduce trading costs ("Costs"); and
- c) how quickly they want to trade ("Time").

Decisions about Quantity, Costs, and Time depend on the goals of the trader, their views about current and future prices of securities, market conditions, their willingness to take on non-execution or partial-execution risk, and other considerations. Each of these may change over time and can vary across securities. All else equal, traders generally prefer lower costs, but in practice, and in view of these considerations, decisions often involve complex tradeoffs across Quantity, Costs, and Time.

7. **Quantity:** How much a large trader wants to trade depends on expected benefits and expected costs. For example, if a large trader views a stock as undervalued, the more exposure they gain to the stock (all else equal), the greater their expected profits. Traders can gain exposure by buying or selling shares, or through derivatives such as total return swaps (where the trader receives or pays the total return on the stock). The expected benefits of more exposure can outweigh any incremental increase in expected trading costs from trading larger quantities. Therefore, the opportunity cost of not achieving the desired exposure can be economically important and is often described as the opportunity cost of not trading. The risk of bearing this opportunity cost is sometimes referred to as non-execution or incomplete execution risk.

8. **Costs:** All else equal, trading costs are one factor for large traders. Paying higher prices to complete buy orders or receiving lower prices on sell orders implies higher trading costs. As discussed below, parent orders are often implemented through a sequence of smaller trades. The first trade can influence the price that the second trade receives from a contra-side trader, which may in turn, affect the third trade, and so on. The movement of prices because of this trading process is sometimes referred to as "price impact." For a number of reasons, trading by large traders may generate price impact.

All else equal, smaller orders, and trades that are completed more slowly, generally have lower price impact. Archegos spread its transactions in the at-issue securities over multiple months and even years.

There are additional trading costs when a large trader wishes to sell short. The large trader must borrow the shares they sell short and pay the lender a fee (a “lending fee”). The number of shares sold short is often described as the “short interest.” Data on short interest and lending fees indicates shares of the at-issue securities were available to short sellers during the relevant period. Lending fees were generally low and short interest was not insignificant.

9. **Time:** How quickly a trader wants to trade may depend on how quickly they think the expected benefit of their trading will diminish and how they anticipate trading more rapidly may add to costs. For example, if a large trader views a stock as undervalued, they want to purchase it before other market participants also realize that the stock is undervalued and bid up prices. As with quantity decisions, the expected benefits of trading quickly can outweigh any incremental increase in expected trading costs from trading quickly. Trading quickly also reduces the risk that the trader will not be able to achieve their desired trade quantity. The failure to fully execute a desired order leads to opportunity costs associated with a no- or partial-execution. Thus, a buyer who anticipates that prices will rise for reasons other than the price impact of their own trades may wish to trade quickly because the expected benefit from completing a trade may still be larger than the incremental costs of faster trading. Separately, speed in execution can be beneficial because it reduces uncertainty about the average price of an order. The importance of speed in the trading ecosystem is underlined by the fact that promotional materials for trading algorithms often emphasize the ability of users to specify “urgency” parameters in their algorithms.

10. Each of the quantity, trading cost, and timing decisions described above are rational economic decisions that large traders make on a routine and continuous basis. Because large traders’ goals, views, and execution risk vary across time (both within and across days) and securities, the mix of these varies as well. For example, it might make perfect sense for a large trader to want to trade quickly and incur higher trading costs under some conditions, while in different conditions, the large trader may want to trade slowly. The sales by certain Archegos counterparties of at-issue securities over a few days at the end of March 2021 are an example of institutions choosing to trade large numbers of shares quickly. Such large and rapid sales are not unusual and are conducted by many institutions. These opinions are supported by the academic and practitioner literature as well as documents produced by Archegos counterparties.

11. Based on the rational economic tradeoffs between Quantity, Costs and Time, a large trader submitting a parent order decides, among other things:

- The maximum quantity of shares it is willing to buy or sell;
- The maximum price it is willing to pay or the minimum price it is willing to accept;
- The time of day to enter an order;
- The maximum duration over which the order will be attempted to be executed;

and

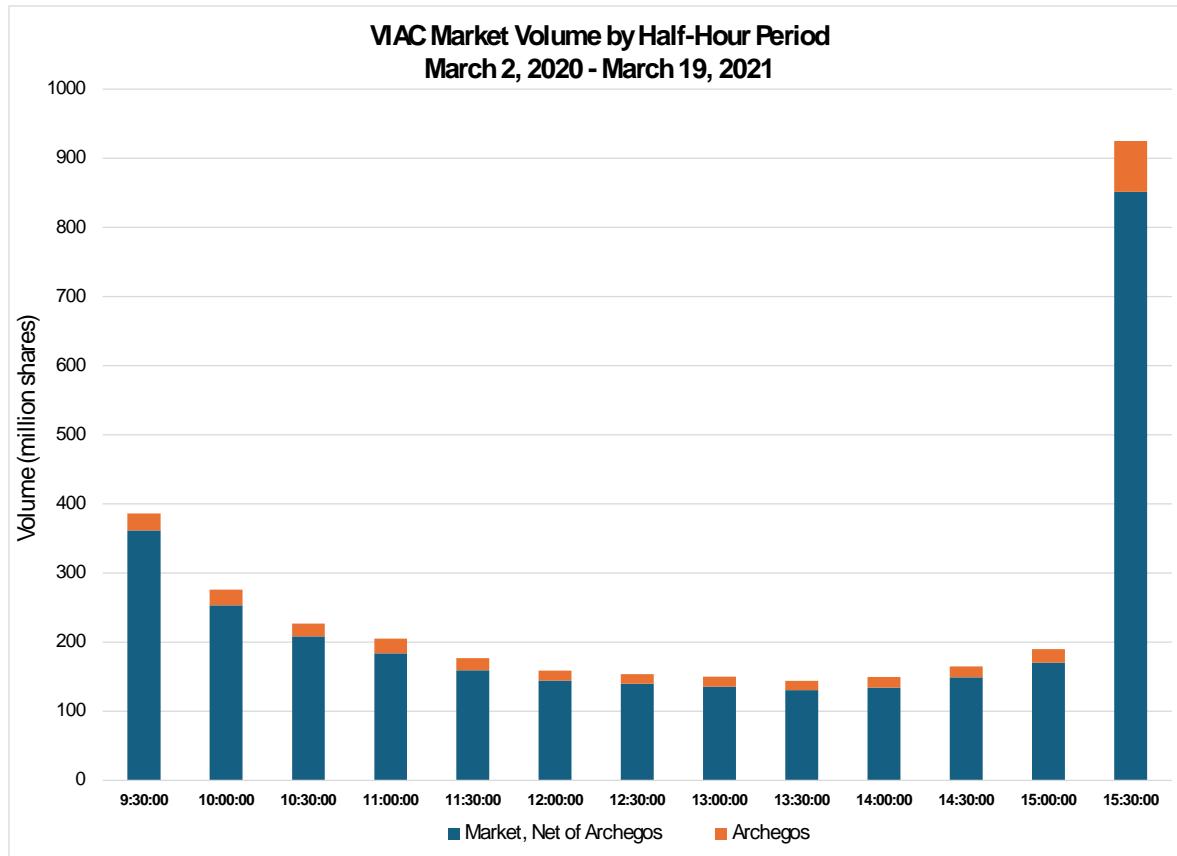
- The intermediaries or counterparties to use.

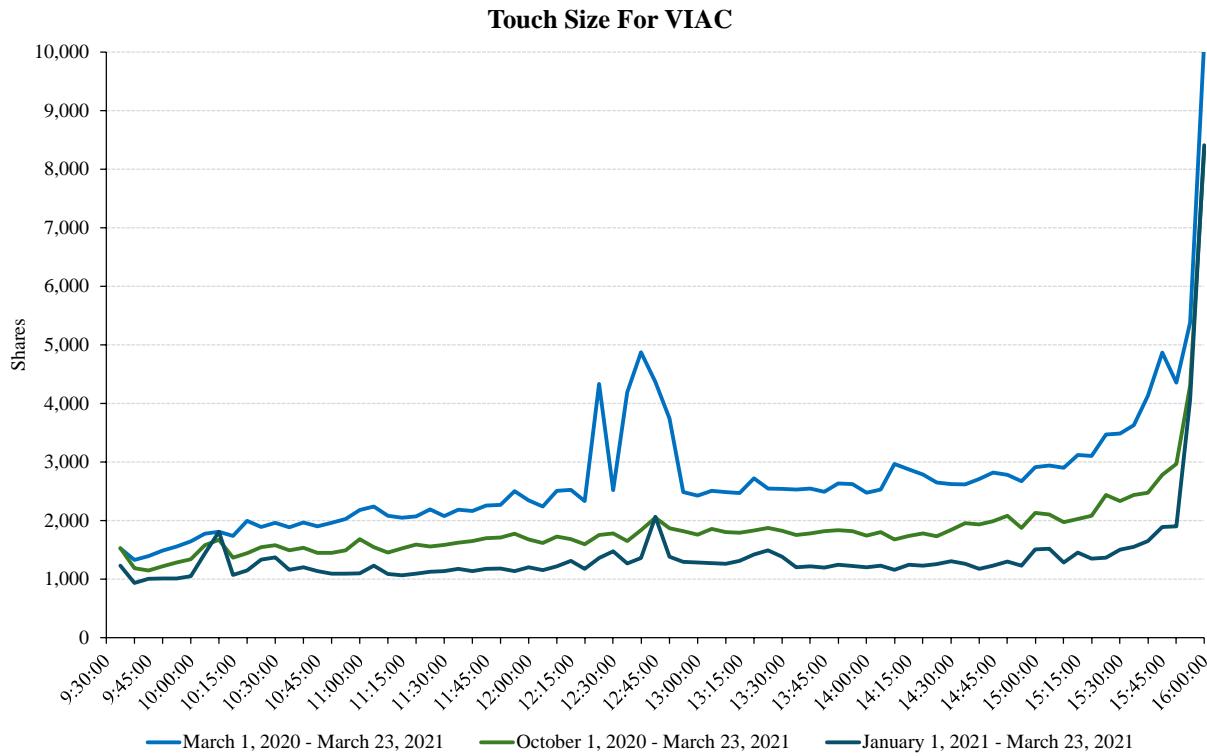
12. Professor Wahal will provide background on how orders are delivered to the marketplace and executed. A large trader creates one or more “parent orders” and sends the parent orders to brokers. The parent order need not reflect the full quantity that the trader wishes to acquire. In fact, the true quantity desired might be the sum of parent orders over days, months or even years (the trading program described earlier); and a large trader may change its desired quantity over time. The parent order may include additional information, such as the trading algorithm that should be used by the broker.

13. The algorithm breaks the parent order up into “child orders.” For each child order, the algorithm, not the trader who submitted the parent order, chooses the size (number of shares), order type and, for limit orders, limit price, subject to any constraints the trader puts on the algorithm (e.g., a maximum price the trader is willing to pay). The algorithm generally chooses whether to place a liquidity-taking (“aggressive”) order that is more likely to execute quickly, or a liquidity-providing (“passive”) order that may or may not execute. Liquidity-taking orders execute relatively quickly because they provide better prices to contra-side traders. Liquidity-providing orders, on the other hand, provide better prices to the large trader but may or may not execute, and if they execute, may take longer to execute. The algorithm (or smart router) also selects the trade venue to which each child order is routed. Child orders may be partially or fully filled, cancelled, modified, or may expire. Trading is normally completed anonymously in electronic markets. It is not unusual for large traders to use multiple brokers.

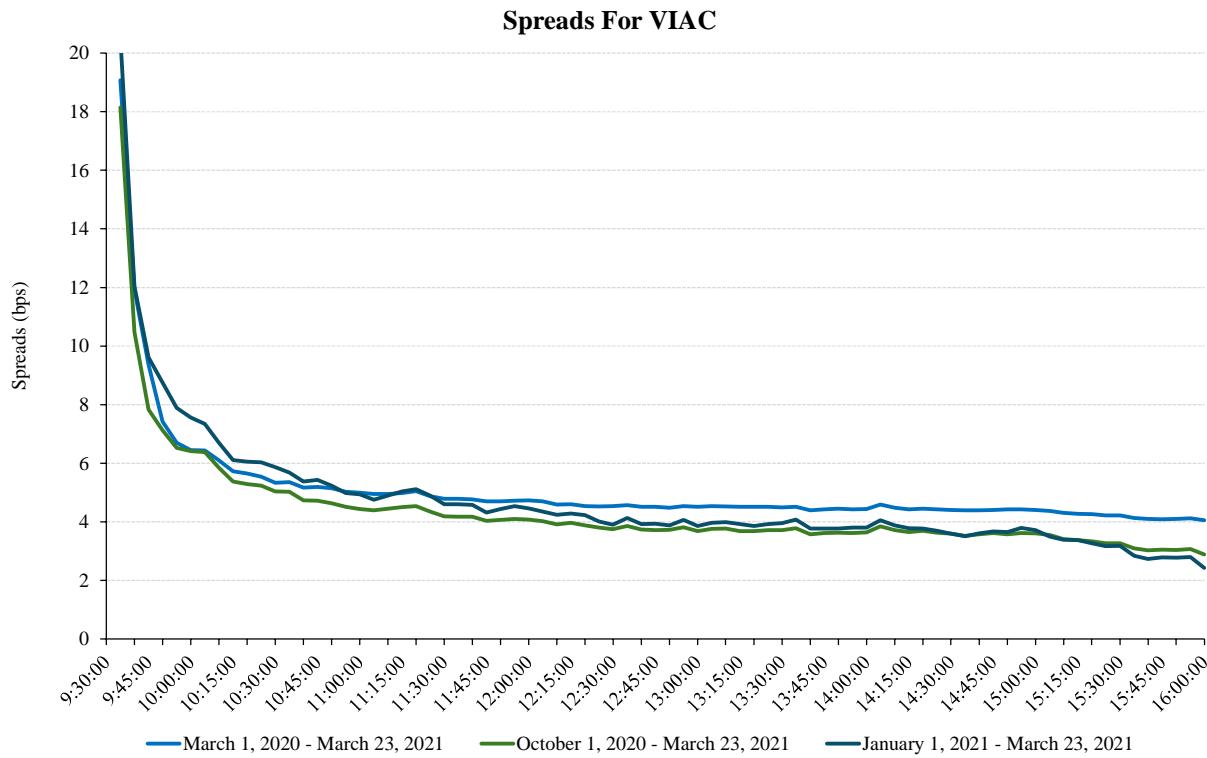
14. Traders continuously reassess the parent order level tradeoffs between Quantity, Costs, and Time. One input to this reassessment may be information on the rate at which the parent order and child orders are filling (or not filling). Other relevant information may include the movement of prices, quotes, trading volume across trading venues, and other such features while the parent order is active. These can cause a trader to cancel or modify the parent order. The algorithm can also cancel or modify child orders without any input from the trader.

15. Professor Wahal is prepared to testify that there are benefits to trading towards the end of the trading day. Other investors are typically seeking to trade more shares at the end of the day, as shown by the higher trading volume and larger amounts of shares available at the Best Bid and Best Offer (i.e. the “touch size”). In addition, the difference between the Best Bid and Offer (i.e. the “Spread”) is generally lowest at the end of the day. This is based on, among other things, analyses of the S&P 500 by Goldman Sachs during the Indictment Period and analysis of the at-issue securities during the same period. This is illustrated by the charts below.





Source: SDNY_P019_0000000001.



Source: SDNY_P019_0000000001.

16. Professor Wahal will also explain what “market on close” and “limit on close” orders are, including that they execute in the closing auctions for the NYSE and Nasdaq, and that Archegos rarely participated in the closing auctions on NYSE or Nasdaq.

17. Professor Wahal is prepared to testify that academic papers have found the pre-market functions well despite lower average liquidity.

18. Archegos used standard algorithms that are provided by many broker-dealers and are routinely used by many institutional investors. Professor Wahal is prepared to testify on the major types of algorithms. Algorithms are automated ways of resolving the Quantity, Cost, and Time tradeoffs described above. A large trader can set bounds (“parameters”) on what an algorithm attempts to do but cannot micromanage decisions for each child order. The algorithm usually selects the trading venue as part of its algorithmic execution process. There is variation in the use of dark pools across algorithms. Certain algorithms are designed to increase their buying (or selling) when prices fall (or rise).

19. Professor Wahal is prepared to testify that VWAP and TWAP algorithms do not inherently cause parent orders to be filled aggressively, whether initiated later in the trading day or otherwise. Such algorithms need not guarantee that a parent order will be fully filled. The actual implementation of algorithms labelled VWAP or TWAP can differ in many ways, including but not limited to, whether they are “best efforts” or “guaranteed” in delivering the benchmark price (VWAP or TWAP). Some other algorithms are more aggressive than VWAP or TWAP. This testimony will be based on the academic and practitioner literature and Professor Wahal’s research and industry experience. Algorithm users can control their economic exposure by placing limit prices for the parent order.

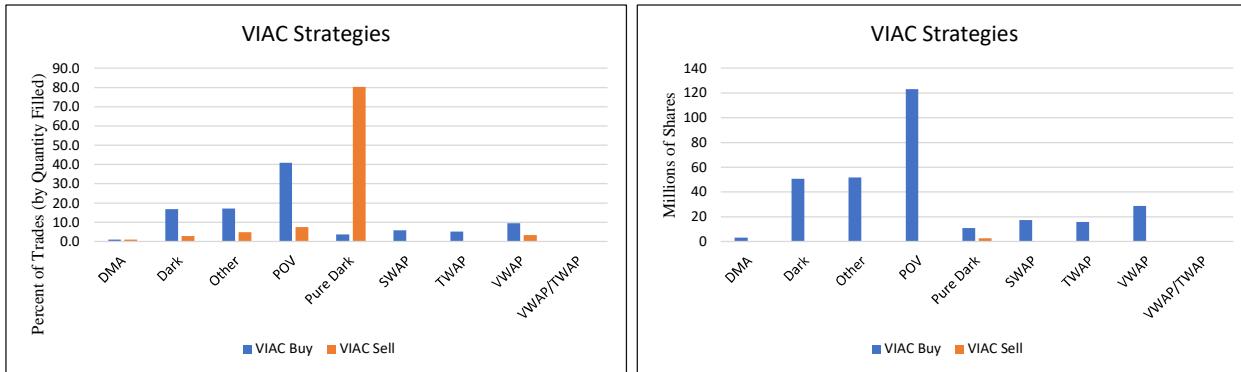
20. Professor Wahal is prepared to provide the following testimony on dark pools. While the characteristics of individual dark pools vary, in general they are trading venues regulated by the SEC that do not display orders to the public prior to trading occurring, and only allow certain investors to trade on them. Other markets also allow for non-displayed orders, and Archegos used non-displayed orders in other venues. Various dark pools use different rules to establish the prices at which trades take place.

21. Professor Battalio states that dark pools “tend to have less price impact than lit markets.” While dark pools may offer lower trading costs, they can generate greater execution uncertainty than lit markets. An order sent to a dark pool may be less likely to be executed in full or in part. Since large traders are generally aware of the tradeoffs between Cost, Quantity, and Time, the decision to send an order to a dark pool may reflect the urgency (or lack thereof) to trade, rather than just a cost consideration.

22. Professor Battalio’s Supplemental Disclosure provides charts of the “Percent of [Archegos] Trades” executed by specific algorithms to “illustrate that Archegos used participation-based and time-based algorithms when [it] executed trades in the same direction as the firm’s overall position but used dark pool algorithms when executing trades in the opposite direction to the firm’s overall position.”² These charts are misleading in the sense that they do not reflect

² Supplemental Disclosure for Professor Robert Battalio, ¶ 101.

relative proportion of buying versus selling activities. The chart on the left is from Professor Battalio's Supplemental Disclosure. The chart on the right modifies Professor Battalio's chart to show the amount of trading by algorithm.



23. Professor Wahal is prepared to testify that a large trader may use multiple algorithms at the same time for a variety of reasons. For example, if one algorithm operates solely in lit markets, the trader may want to use a dark-only algorithm at the same time.

24. Professor Wahal is prepared to testify that the algorithm, not the trader, chooses the size of each child order and whether each child order will be aggressive (take liquidity) or passive (provide liquidity by posting resting orders). He is also prepared to testify that it is natural that an algorithm attempting to implement a larger parent order might use a larger proportion of liquidity-taking child orders, and/or larger child order sizes. He will also explain that Professor Battalio's purported analyses of the differences between aggressive and passive child orders, and the differences between Archegos trades and "non-Archegos" Trades reach conclusions that are not meaningful and, in some cases, incorrect.

25. Multiple analyses by Professor Battalio rely upon his "Trade Mapping." His Trade Mapping attempts to match trades in the Bloomberg EMSX data (containing executions of Archegos child orders) to the TAQ trade data and Nasdaq execution data. Professor Battalio relies upon this matching to categorize trades as being either a) executions of child orders related to Archegos (generally by counterparties to hedge Archegos swaps) or b) executions unrelated to Archegos. The following analyses are compromised if Professor Battalio's mapping is unreliable:

- Battalio's Primary midpoint analysis.
- Battalio's Nasdaq Approach.
- Tables 22, 24, 25 & 26 of Battalio's Supplemental Disclosure.

Professor Wahal is prepared to testify that Professor Battalio's mapping is flawed. First, Professor Battalio's Supplemental Disclosure shows he cannot match some fraction of Archegos-Related Trades to trades reported in TAQ or Nasdaq within a reasonable time frame. Second, Professor Battalio assumes a match even if he cannot line up the exchange reported in the Bloomberg EMSX data with the exchange reported in the TAQ data or the Nasdaq data. Professor

Battalio's matching tolerances are also inconsistent with the timeframes used in his subsequent analyses. Finally, Professor Battalio's and Dr. Taveras's matching programs are not consistent with each other. They do not identify the same trades as Archegos-Related Trades and use different timeframes.

26. Professor Wahal is prepared to testify that Professor Battalio's "Primary Approach" to estimating the effect of Archegos trading on the future midpoint of the bid-ask spread, and his interpretation of his results, is flawed.

First, even if Professor Battalio's computations were flawless, they would simply show that Archegos' trade executions have price impact. Price impact is entirely normal and part of a well-functioning market.

Second, Professor Wahal is prepared to testify that there are internal inconsistencies in Dr. Battalio's Primary Approach, that he uses methodologies that are non-standard, and that they render his conclusions incorrect and misleading.³ Professor Wahal will discuss the impact of Dr. Battalio's methodological choices in computing Price Contribution, Price Impact and Realized Spreads.

Third, Professor Battalio's comparisons of the price contribution/price impact/realized spread of Archegos-Related Trades to that of non-Archegos-Related Trades is further flawed because the latter set of trades includes trades originating from all other market participants, including, but not limited to, retail investors, index funds, institutions, and liquidity providers. Trades from some of these other market participants are not comparable to the trades of large traders, such as Archegos.

Finally, Professor Wahal is prepared to testify that there is no evidence that Archegos harmed liquidity providers.

27. Professor Wahal will explain that Professor Battalio's Nasdaq Approach, which includes both his "main" method and his "trade-to-trade alternative" method, is unreliable because it suffers from many of the same problems as his Primary Approach, and contains additional problems of its own. Professor Battalio's Nasdaq Approach is inconsistent with his Primary Approach. Among other things, he uses different timeframes and measures of the quote midpoint in his Primary Approach versus in his Nasdaq Approach. His analyses for both the main method and the trade-to-trade alternative method also require unsupported and unsubstantiated assumptions that are unrealistic. The potential flaws include the following: summing short horizon price impact lacks support in the academic literature and implicitly assumes that stock prices do not revert post-trade. Professor Battalio also has not attempted to determine whether his result is statistically significant, even though any estimate of price impact over such a long period is likely to be very imprecise.

³ The defense will produce the programs underlying Professor Wahal's analysis.

28. The government states that, based on the results of his VAR analysis, “Professor Battalio will opine that Archegos’ order activity led to price increases for the Archegos Top Long Positions.” Professor Wahal is prepared to testify that this conclusion is unreliable. First, one cannot draw conclusions about causality from a VAR analysis because of the *post hoc ergo propter hoc* fallacy. Second, even if Archegos’ trades were shown to affect prices, this simply shows that trading has price impact.

29. Professor Wahal is prepared to testify that Professor Battalio’s interpretation of his implementation shortfall analysis is flawed because it ignores the potential cost of trades that were not filled. The importance of this cost has long been recognized in the academic literature. In addition, Archegos differs from other large investors in ways that would be anticipated to affect the Implementation Shortfall.

30. Dr. Taveras purports to identify instances where stock prices rose after Archegos increased its limit prices on buy orders. She asserts this is highly unusual. Professor Wahal is prepared to testify that there is nothing surprising about this. Large traders attempt to manage the tradeoff between Quantity, Costs (and therefore limit prices), and Time. If prices rise, and the trader has not bought desired Quantities, it is natural to increase limit prices to achieve their trading objectives. That results in more trading, which may naturally generate price impact.

31. Professor Battalio purports to show Archegos was more likely to increase the size of its parent orders when prices fell and that prices generally rose after Archegos increased the size of its parent orders after price declines. Professor Wahal is prepared to testify that buying on price declines is consistent with trying to acquire a large stake at the lowest cost and any price increases after Archegos increased the quantity of a parent order may reflect the fact that trading may have price impact.

32. Professor Battalio purports to show that Archegos increased its limit prices after prices rose, and that prices continued to rise after Archegos increased its limit prices. Professor Wahal is prepared to testify that, as described above, increasing limit prices after prices rise is consistent with trying to acquire a large stake. Any price increases after Archegos increases the limit price of a parent order may reflect the fact that trading may affect subsequent prices.

33. Professor Wahal is prepared to testify that examples of purported “uneconomic trading” identified by government experts have rational economic explanations.

III. RESERVATION OF RIGHTS TO SUPPLEMENT DISCLOSURES

The defense reserves their right to supplement and/or amend these disclosures, including in response to the government’s disclosures and the evidence presented in its case-in-chief.

Please let us know if you have any questions. We are available to meet and confer to further discuss these disclosures.

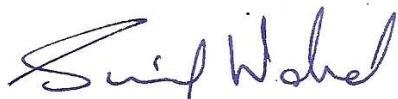
Very truly yours,



Barry H. Berke
Dani R. James
Jordan Estes

cc: Mary E. Mulligan
Timothy M. Haggerty

Reviewed and Approved by:



Sunil Wahal

Appendix A

Archegos Portfolio and Trading Records

- Archegos Aexo, SDNY_P002_0000023044 and SDNY_P002_0000023045.
- Recently produced Bloomberg EMSX data, SDNY_P022_0000000003 and SDNY_P022_0000000004.

Counterparty Documents

- SDNY_P001_0004572881.
- SDNY_P001_0004868379.
- SDNY_P001_0004951401.
- SDNY_P001_0004961452.
- SDNY_P016_0000010799.
- SDNY_SWR_0001307819-22.
- SDNY_SWR_0000463011.
- SDNY_SWR_0000340139-42.
- SDNY_002_00000672.

Witness Statements

- 3592-001.

Other Sources

- Robert Almgren, and Neil Chriss. “Optimal Execution of Portfolio Transactions.” *Journal of Risk* 3, 2001.
- Jeffrey M. Bacidore. *Algorithmic Trading: A Practitioner’s Guide*. TBG Press, 2020.
- Michael J. Barclay, and Terrence Hendershott. “Price discovery and trading after hours.” *Review of Financial Studies* 16, 1041-1073, 2003.
- Michael J. Barclay, and Terrence Hendershott. “Liquidity Externalities and Adverse Selection: Evidence from Trading After Hours.” *Journal of Finance* 59, 2004.
- Tyler Beason, and Sunil Wahal. “The Anatomy of Trading Algorithms.” *SSRN Scholarly Paper*, 2020.
- Markus K. Brunnermeier, and Lasse Heje Pedersen. “Market Liquidity and Funding Liquidity.” *Review of Financial Studies* 22, 2009.
- Jennifer Conrad, Sunil Wahal, and Jin Xiang. “High-frequency quoting, trading, and the efficiency of prices.” *Journal of Financial Economics* 116, no. 1: 271-291, 2015.
- Jennifer Conrad and Sunil Wahal. “The Term Structure of Liquidity Provision.” *Journal of Financial Economics* 136, 2020.
- Credit Suisse Group Special Committee of the Board of Directors. “Report on Archegos Capital Management.” Credit Suisse, July 29, 2021. SDNY_P001_0000055859.
- Harold Demsetz. “The Cost of Transacting.” *Quarterly Journal of Economics* 82, 1968.
- “Disclosure of Order Execution Information. RIN 3235-AN22.” SEC, March 6, 2024.
- Gregory W. Eaton, Paul J. Irvine, and Tingting Liu. “Measuring Institutional Trading Costs and the Implications for Finance Research: The Case of Tick Size Reductions.” *Journal of Financial Economics* 139, 2021.

- Robert F. Engle, Robert Ferstenberg, and Jeffrey Russell. “Measuring and Modeling Execution Cost and Risk.” *Journal of Portfolio Management* 38, 2012.
- Andrea Frazzini, Ronen Israel, and Tobias J. Moskowitz. “Trading Costs.” *SSRN Scholarly Paper*, 2018. KL-BH-00021418.
- Larry Harris. *Trading & Exchanges, Market Microstructure for Practitioners*. Oxford University Press, 2003.
- Larry Harris. *Trading and Electronic Markets: What Investment Professionals Need to Know*. CFA Institute Research Foundation, 2015.
- Joel Hasbrouck. *Empirical Market Microstructure: The Institutions, Economics, and Econometrics of Securities Trading*. Oxford University Press, 2007.
- Liz Hoffman, Corrie Driebusch, and Tom McGinty. “Big Stock Sales Are Supposed to Be Secret.” *Wall Street Journal*. March 30, 2022.
- Liz Hoffman, Corrie Driebusch, and Tom McGinty. “How We Analyzed Wall Street Block Trades.” *Wall Street Journal*. March 30, 2022.
- Craig W. Holden, Matthew Pierson, and Jun Wu. “In the Blink of an Eye: Exchange-to-SIP Latency and Trade Classification Accuracy.” *SSRN Scholarly Paper*, 2023.
- Christine X. Jiang, Tanakorn Likitapiwat, and Thomas H. McInish. “Information Content of Earnings Announcements: Evidence from After-Hours Trading.” *Journal of Financial and Quantitative Analysis* 47, 2012.
- Donald Keim, and Ananth Madhavan. “The cost of institutional equity trades.” *Financial Analysts Journal* 54, 50-69, 1998.
- Albert J. Menkveld, Bart Zhou Yueshen, and Haoxiang Zhu. “Shades of Darkness: A Pecking Order of Trading Venues.” *Journal of Financial Economics* 124, 2017.
- Maureen O’Hara. *Market Microstructure Theory*. John Wiley & Sons, 1998.
- Andre F. Perold. “The Implementation Shortfall: Paper Versus Reality.” *Journal of Portfolio Management* 14, 1988.
- Mehmet Saglam, Ciamac C. Moallemi, and Michael G. Sotiropoulos. “Short-term Trading Skill: An Analysis of Investor Heterogeneity and Execution Quality.” *Journal of Financial Markets* 42, 2019.
- Sunil Wahal. “Electronic Markets and Trading Algorithms.” *The Journal of Trading* 7, 2012.
- Liyan Yang and Haoxiang Zhu. “Back-Running: Seeking and Hiding Fundamental Information in Order Flows.” *Review of Financial Studies* 33, 2020.

Public Data

- Short interest and borrowing rate data, KL-BH-00023361, and KL-BH-00023362, KL-BH-00023363.
- Daily TAQ client specifications, NYSE. Version 4.0
- TAQ data, SDNY_P016_0000000001.
- NBBO data, SDNY_P019_0000000001.

EXHIBIT A

Sunil Wahal

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LinkedIn: sunil-wahal-7b823323b

EDUCATION

University of North Carolina Chapel Hill, NC
Ph.D., Finance 1995

Wake Forest University Winston-Salem, NC
MBA 1989–1995

Delhi University, Sri Ram College of Commerce Delhi, India
BA (Hons) Economics 1986–1989

RESEARCH AREAS

Market Microstructure and Trading, Institutional Investors, Asset Pricing

ACADEMIC EXPERIENCE

Arizona State University, WP Carey School of Business Tempe, AZ
Jack D. Furst Professor of Finance 2005–Current
Director, Center for Responsible Investing

Emory University, Goizueta Business School Atlanta, GA
Associate Professor, Area Chair 2002–2005
Assistant Professor 1997–2002

Purdue University, Krannert Graduate School of Management West Lafayette, IN
Assistance Professor 1995–1997

NON-ACADEMIC EXPERIENCE

Avantis Investors Los Angeles, CA
Partner, Consultant 2019–Current

Dimensional Fund Advisors Austin, TX
Consultant 2005–2019
Vice-President 2008–2010

Versant Capital Management 2018–Current
Investment Committee (Pro Bono)

Strategy Research Foundation
Investment Committee (Pro Bono)

Wipfli Financial Advisors 2018–2022
Investment Committee

Heritage Financial Services 2020–2020
Investment Committee

Mercer Investment Advisors

Investment Committee

2012-2014

AJO Partners

Consultant

Philadelphia, PA

2003

Cornerstone Research

Expert Witness

WORKING PAPERS

1. Goyal, Amit and Sunil Wahal, 2023, "R&D, Expected Profitability, and Expected Returns", Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4339765
2. Goyal, Amit, Sunil Wahal, Deniz Yavuz, 2022, "Choosing Investment Managers", Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3651476
3. Goyal, Amit, Sunil Wahal, Deniz Yavuz, 2022, "Picking partners: Manager Selection in Private Equity", Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3910494
4. Wahal, Sunil and Albert Wang, 2022, "Flow diversification", Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4013988
5. Tyler Beason and Sunil Wahal, 2021, "The anatomy of trading algorithms", Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=349700
6. Repetto, Eduardo and Wahal, Sunil, 2021, "On the Conjoint Nature of Value and Profitability", Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3635714

PUBLICATIONS (REFEREED)

1. Goyal, Amit, Ramon Tol, and Sunil Wahal, "Forbearance in Institutional Investment Management: Evidence from Surey Data", Forthcoming, *Financial Analysts Journal*.
2. Mehra, Rajnish, Sunil Wahal, and Daruo Xie, 2021, "Is Idiosyncratic Risk Conditionally Priced?", *Quantitative Economics*, Vol. 12, no.2, pp. 625-646
3. Aragon, George, Rajnish Mehra, and Sunil Wahal, 2020, "Do properly Anticipated Prices Fluctuate Randomly? Evidence from VIX Futures Markets", *The Journal of Portfolio Management*, Vol. 466, no.7, pp. 144-159
4. Conrad, Jennifer and Sunil Wahal, 2020, "The Term Structure of Liquidity Provision", *Journal of Financial Economics*, Vol. 136, no.1, pp. 239-259
5. Sunil Wahal, 2019, "The Profitability and Investment Premium: Pre-1963 Evidence", *Journal of Financial Economics*, Vol. 131, no.2, pp. 362-377
6. Conrad, Jennifer, Sunil Wahal, and Jin Xiang, 2015, "High-Frequency Quoting, Trading, and the Efficiency of Prices", *Journal of Financial Economics*, Vol. 116, no.2, pp. 271-291
7. Goyal, Amit and Sunil Wahal, 2015, "Is Momentum an Echo?", *Journal of Financial and Quantitative Analysis*, Vol. 50, no.6, pp. 1237-1267
8. Busse, Jeffrey, Amit Goyal, and Sunil Wahal, 2014, "Investing in a Global World", *Review of Finance*, Vol. 18, no.2, pp. 561-590
9. Yavuz, Deniz M., and Sunil Wahal, 2013, "Style Investing, Comovement and Return Predictability", *Journal of Financial Economics*, Vol. 107, no.1, pp. 136-154

10. Wahal, Sunil and Wang, Albert Yan, 2011, "Competition among Mutual Funds", *Journal of Financial Economics*, Vol. 99, no.1, pp. 40-59
11. Busse, Jeffrey A, Amit Goyal, Sunil Wahal, 2010, "Performance and Persistence in Institutional Investment Management", *Journal of Finance*, Vol. 65, no.2, pp. 765-790
12. Goyal, Amit and Sunil Wahal, 2008, "The Selection and Termination of Investment Management Firms by Plan Sponsors", *Journal of Finance*, Vol. 63, no.4, pp. 1805-1847
13. Lee, Peggy, and Sunil Wahal, 2004, "Grandstanding, Certification and the Underpricing of Venture Capital Backed IPOs", *Journal of Financial Economics*, Vol. 73, no.2, pp. 375-407
14. Conrad, Jennifer, Kevin M. Johnson, and Sunil Wahal, "Institutional Trading and Alternative Trading Systems", *Journal of Financial Economics*, Vol. 70, no.1, pp. 99-134
15. Badrinath, Swaminathan and Sunil Wahal, 2003, "Momentum Trading by Institutions", *Journal of Finance*, Vol. 57, no.6, pp. 2449-2478
16. Khorana, Ajay, Sunil Wahal, and Marc Zenner, 2002, "Agency Conflicts in Closed-End Funds: The Case of Rights Offerings", *Journal of Financial and Quantitative Analysis*, Vol. 37, no.2, pp. 177-200
17. Conrad, Jennifer, Kevin M. Johnson, and Sunil Wahal, 2001, "Institutional Trading and Soft Dollars", *Journal of Finance*, Vol. 56, no.1, pp. 397-416
18. McConnell, John J and Mehmet Ozbilgin, and Sunil Wahal, 2001, "Spin-offs, Ex Ante", *The Journal of Business*, Vol. 74, no.2, pp. 245-280
19. McConnell, John J and Sunil Wahal, 2000, "Do institutional investors exacerbate managerial myopia?", *The Journal of Corporate Finance*, Vol. 6, no.3, pp. 307-329
20. Sunil Wahal, 1997, "Entry, Exit, Market Makers, and the Bid-Ask Spread", *The Review of Financial Studies*, Vol. 10, no.3, pp. 871-901
21. Sunil Wahal, 1996, "Pension fund activism and firm performance", *Journal of Financial and Quantitative Analysis*, Vol. 31, no.1, pp. 1-23
22. Wahal, Sunil, Kenneth Wiles, and Marc Zennerl, 1995, "Who Opts Out of State Antitakeover Protection?: The Case of Pennsylvania's SB 1310", *Financial Management*, pp. 22-39

PUBLICATIONS (NON-REFEREED)

1. Sunil Wahal, "Electronic Markets and Trading Algorithms", 2012, *Journal of Trading*, pp. 1-11.
2. Conrad, Jennifer S and Kevin M. Johnson, and Sunil Wahal, 2003, "Institutional Trading Costs and Trading Systems", *Equity Trading and Analysis, AIMR*, Vol. 12, no.7, pp. 1-12.
3. Conrad, Jennifer S, Kevin M. Johnson, and Sunil Wahal, 2003, "The Trading of Institutional Investors: Theory and Evidence", *Journal of Applied Finance*, pp. 1-12.

TEACHING

- **Arizona State University**, WP Carey School of Business
ASU-SAIF DBA Program, Shanghai
 Global Financial Systems: Institutional Investors
Executive Program
 Applied Financial Management
Evening Program
 Corporate Finance

FT MBA Program
Corporate Finance
Portfolio Engineering
Student Investment Management Fund*

Undergraduate Program
Entrepreneurial Finance and Private Equity
Portfolio Engineering
Student Investment Management Fund*

* The Student Investment Management (SIM) Fund dovetails with Portfolio Engineering and is designed as an integrated program to create the next generation of quantitatively inclined students for the asset management industry. Assets are managed using quantitative strategies (not fundamental analysis) derived from research published top-tier academic journals. Students integrate the portfolio management experience with the ability to handle data from a variety of sources, write code, and assess tradeoffs in live portfolios. Graduating students are frequently placed at well-known asset managers (buyside firms, hedge funds, and private equity), RIAs, family offices, SWFs, and investment boutiques. A handful go to on Ph.D. programs.

- **Emory University**, Goizueta Business School

Executive Program
Corporate Control (WEMBA Program)
Corporate Control (Modular EMBA Program)
Financial Decision Making (DLHPM Program)

MBA Program
Corporate Control

BBA Program
Corporate Control
Corporate Finance

- **Purdue University**, Krannert Graduate School of Management

Ph.D. Program
Seminar in Corporate Finance

Undergraduate Program
Financial Management

- **University of North Carolina at Chapel Hill**, Kenan-Flagler Business School

Undergraduate Program
Financial Management

ACADEMIC PRESENTATIONS

American Economic Association, various years
American Finance Association, various years
European Finance Association, various years
Financial Management Association, various years
NBER, various years and programs
Western Finance Association, various years

Notre Dame Investment Management Conference, 2022
UNC-IPC, 2022
Oxford PERC, 2022
ITAM Finance, 2022
Imperial College, 2021
Georgetown University, 2021
World Symposium of Research, 2021
SEC/Maryland Conference on Financial Market Regulation, 2021

Market Microstructure Exchange, 2020
Microstructure Asia-Pacific, 2020
SMU, 2020
Purdue University, 2019
Nippon Finance Association, 2018 NFA, 2018
Napa Valley Conference, 2017
Finance Down Under, 2017
ITAM, 2016
WU Guttman Center, 2016
Vienna University of Economics and Business, 2016
SEC-Center for Financial Policy Conference, 2014
Stern Microstructure Conference, 2014
Texas Quantitative Finance Festival, 2013
Financial Market Conference, Vanderbilt University, 2013
Hitotsubashi University, 2013
5th Hedge Fund Research Conference, 2013
University of Toronto, 2011
Babson College, 2011
Texas Christian University, 2011
Univeristy of Utah, 2011
Cass Business School, 2010, "Leading Lights in Fund Management"
CRSP Forum, 2008
University of Virginia, 2007 and 2019
University of Calgary, 2007
National University of Singapore, 2006
Singapore Management University, 2006
University of North Carolina at Chapel Hill, 2006
Mitsui Life Symposium, University of Michigan, 2005
Boston College, 2005
UC Irvine, 2005
Arizona State University, 2005
Roudtable for Engineering Entrepreneurship Research, 2004
University of Washington, 2004, 2017
Hong Kong University of Science and Technology, 2004
Vanderbilt University, 2004
Yale EVI conference, 2002
University of Florida, 2001
University of Kansas, 2000
Southern Methodist University, 2000
University of Western Ontario, 2000
Association of Financial Economists (ASSA), 1999
Georgia State University, 1998
University of Utah, 1997
University of Miami, 1997
University of Georgia, 1997
Association of Financial Economists (ASSA), 1996
University of Georgia, 1995
Case Western Reserve University, 1995
Purdue University, 1995
University of Notre Dame, 1995

University of North Carolina, 1995

NON-ACADEMIC PRESENTATIONS

A number of presentations (unlisted to preserve confidentiality) to a variety of audiences including but not limited to Sovereign Wealth Funds, Endowments, Foundations, Pension and Union Plans, and Registered Investment Advisors (RIAs). Topics include asset allocation, investment strategies, and trading issues.

“Rung the closing bell” at NYSE for the launch of 4 ETFs on behalf of Avantis Investors.

Presentations to various CFA Societies, FPAs, and several podcasts (e.g. Bogleheads, The ETF Store, Index Fund Advisors, etc.)

Partial List of Presentations

Benefits Canada: Investment Innovation, 2022

Avantis Investors/American Century, 2022

Dimensional Fund Advisors, multiple years and multiple events

Institutional Investor Conferences, 2021

AQR, 2021

Q-Group, 2021, 2022

WU Guttmann Center, 2016

IMN Global Indexing Conference, 2016

Bank of Korea Academy, 2015

Tokyo Stock Exchange, 2014

Instinet Global Conference, 2013

Pensions Investment Association of Canada, 2013

Barclays Global Investors, 2005

Goldman Sachs (GSAM), 2005

New York Stock Exchange, 2004

Atlanta Society of Financial Analysts, 2003

Instinet Inc, 2001

Equity Investment Strategies Summit, 1998

Plexus Group, 1998

EDITORIAL POSITIONS AND REVIEWS

Associate Editor: Journal of Banking and Finance (2015-Current)

Editorial Board: Annals of Finance (2017 - current)

Associate Editor: Financial Management (2011-2016)

Editorial Board: FMA Survey and Synthesis Series

Refereeing Service:

American Economic Review, Financial Management, Journal of Corporate Finance, Journal of Finance, Journal of Financial Economics, Journal of Financial and Quantitative Analysis, Journal of Financial Services Research, Managerial and Decision Economics, Review of Financial Studies, Review of Asset Pricing Studies, National Science Foundation

AWARDS

• Inquire Europe	2020
• Spangler IQAM Prize for the best paper on Investments	2014
• Distinguished Alumni Speaker, University of North Carolina	2006
• Q-Group Grant	2004
• Emory Williams Distinguished Teaching Award	2004
• Purdue Research Foundation Grant	1997
• Jay N. Ross Young Faculty Scholar Award	1995

PROFESSIONAL SERVICE

External expert for tenure and promotion decisions at a variety of institutions, 2010-current

External expert for NSF grants and HKUGC grants, various years

Program Committee, ASU Sonoran Winter Finance Conference, 2012-present

Program Committee, European Finance Association, 2003-present

Program Committee, Financial Management Association, various years

Program Committee, Indian School of Business Conference, various years

Program Committee, McGill Asset Management Conference

Program Committee, Microstructure Exchange

Program Committee, Napa Valley Conference, 2012-present

Program Committee, Western Finance Association, 2012-present

Program Committee, World Symposium of Investment Research

Awards Committee, Financial Management Association, 2006

Track Chair, Financial Management Association, 2003

UNIVERSITY SERVICE

Director, Center for Responsible Investing, ASU 2022- Director, Center for Investment Engineering, ASU 2017-2022 Chair Search Committee, ASU

Masters Program Committee, ASU, various years

Recruiting Committee, ASU, various years

University Promotion and Tenure Committee, ASU 2013-2016

Faculty Council, ASU, 2010-2012, 2014-2016

Chair, Promotion and Tenure Committee, ASU, 2005-2008, 2010-2011

Member, Recruiting Committee, ASU, 2005-2008, 2010-2011

Governance Committee, ASU, 2010-2011

Area Coordinator, Finance Area, Emory University, 2003-2005

Member, External Affairs Committee, Emory University, 2004-2005

Academic Council, Emory University, 2003-2005

Chair, Research Committee, Emory University, 2002-2004

Chair, Computing and Education Committee, Emory University, 2000-2002

Member, Computing and Education Committee, Emory University 1999-2000

PH.D. STUDENTS

Lingyan Yang (Co-Chair), 2022

Ariel Lohr, 2022

Tyler Beason (Co-Chair), 2021

Pedram Jahangiry, 2016

Daruo Xie (Co-Chair), 2015
Jin Xiang (Co-Chair), 2013
Zhiyi Qian (Chair), 2012
Marko Svetina (Chair), 2008
Zhi Li, 2008
Chris Clifford, 2008
George Cashman, 2007
Albert Wang, 2007
Bharath Thothadri, 1997
Erik Lie, 1996
David Haushalter, 1996
Tim Kruze, 1996

PROFESSIONAL AFFILIATIONS

American Economic Association
American Finance Association
Financial Management Association
Society for Financial Studies